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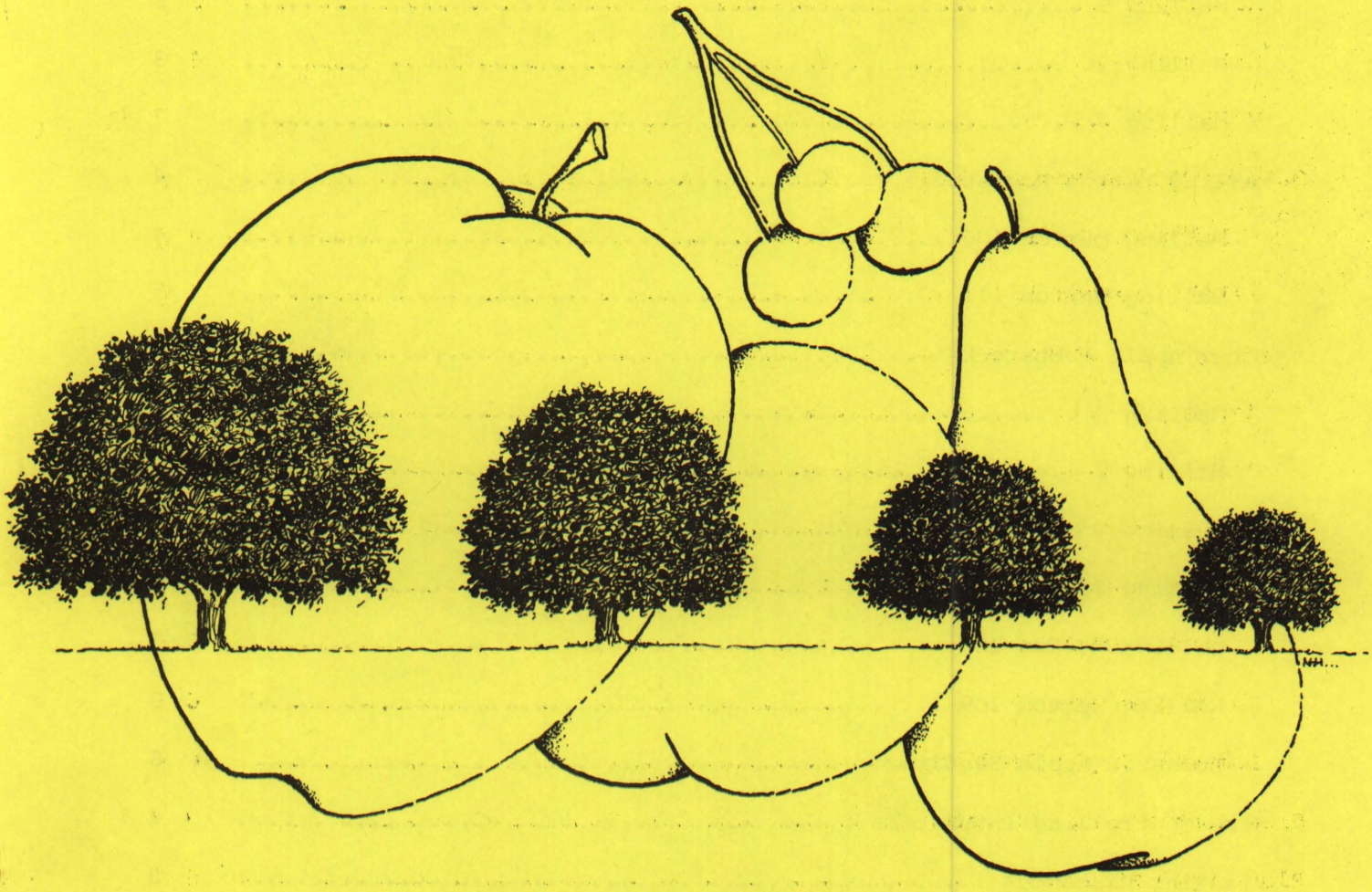
Status of Size Controlling Rootstocks and Interstems for Fruit Trees in Ohio



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STATUS OF SIZE CONTROLLING ROOTSTOCKS AND INTERSTEMS FOR FRUIT TREES IN OHIO

David C. Ferree and Fred O. Hartman

In recent years both commercial orchardists and hobbyists have developed keen interests in dwarf and semidwarf fruit trees. Commercial fruit growers have been faced with rising costs and a decreasing labor supply which have forced them to look for more efficient means of production. For the homeowner a small tree is easier to spray and prune and requires a smaller amount of space in their home landscape.

Smaller trees reduce orchard costs and improve pruning efficiency because a greater percentage of the job can be accomplished from the ground. Harvest is also enhanced for this same reason enabling the fruit to be picked closer to optimum maturity which in turn promotes better storage and shelf life. Since trees produced on most size controlling rootstocks began bearing earlier than trees on conventional seedling roots, the orchard starts paying for itself at an earlier age. Smaller trees are generally planted closer both in the row and between rows thus making more efficient use of the land devoted to orchards. Research has shown that smaller trees present a much greater percentage of their leaf surface to optimum light conditions for fruit production than do conventional large trees. This more efficient photosynthetic surface results in larger yields of high quality fruit per unit of land area. Realizing these advantages of smaller trees orchardists are rapidly replacing conventional trees on seedling rootstocks with smaller trees on size controlling rootstocks.

Understanding some of the basic characteristics of the rootstocks to be used is essential if success is to be realized. Many of the failures and disappointments experienced by both commercial growers and home gardeners can be attributed to a lack of knowledge of the rootstock used. The purpose of this brief outline is to provide information relative to the more important size controlling stocks available. It is important that the reader avoid selecting or discarding a rootstock based on a single characteristic such as tree size or disease susceptibility. The advantages and disadvantages of each stock must be weighed against the alternatives available. With today's economic situation a commercial grower can no longer afford to plant and manage the large spreading tree. Home owners too are cautioned against the advisability of planting full size fruit trees except for shade because of the difficulty of disease control.

APPLE

MALLING ROOTSTOCKS

Malling 8

This rootstock is slightly more dwarfing than M 9. According to the New York Agricultural Experiment Station, M 8 cannot be distinguished from Clark's Dwarf. M 8 has been used as an intermediate stem piece to produce small trees that do not

require support. The trees produced by this technique with Clark's Dwarf have generally been unsatisfactory. M 8 is not being used to any extent at this time and is not recommended.

Malling 9

In several European countries this is the most widely planted clonal rootstock, and it has been used for many years to produce the dwarf trees for their high density management systems. This rootstock produces trees that are 1/4 to 1/3 the size of trees on seedling rootstocks, and it is the only rootstock now recommended that allows all cultural operations to be accomplished without the aid of ladders.

The roots of M 9 are brittle in nature with a greater ratio of bark to wood in the roots than the more vigorous rootstocks. The thick bark makes M 9 more attractive to mice and control measures must be used to avoid mouse damage. Since M 9 roots break readily when put under stress, it is essential that all trees on M 9 be supported for the life of the tree. Support may be in the form of a 2-3 inch diameter post inserted approximately 6 inches from the tree at planting time or by a wire trellis with line posts 40-45 feet apart.

Trees on M 9 start bearing very early in life, and generally it is wise to remove all fruit for the first 3 years to help insure adequate growth. Trees on M 9 tend to be more open and spreading than when grown on a more vigorous rootstock. Thus care must be exercised if a central leader tree is to be established. Because of the compact nature of the root systems of closely planted trees weed competition must be removed particularly from around young trees. Trees on M 9 will do well on soils with a high water holding capacity. Planting should be avoided on exceptionally well drained or soils subject to drought. To help insure early returns from a planting on M 9 it is very important to avoid anything that slows growth in the early life of the trees.

Tests indicate that M 9 is in the same winter hardiness class as domestic seedling rootstock. M 9 does harden off early in the fall and also causes the scion cultivar to harden off early. Although not shown conclusively the trees should be less susceptible to injury from early fall freezes. With trees on M 9 the fruits frequently mature one week in advance of those on M 7 or on standard non-dwarfing roots.

Of all the rootstocks available M 9 is one of the most resistant to collar rot. However, it is susceptible to fireblight in the nursery. Since it tends to sucker from the roots, these suckers must be removed if fireblight is a severe problem. There are no known reports of a direct fireblight infection in the rootstock when a scion cultivar is propagated on it.

Interest in M 9 as a rootstock for commercial plantings in Ohio has grown in recent years. The small size and high yields per acre with close planting make it ideal for pick your own operations. However, commercial growers must be cautioned that trees on M 9 require a higher degree of orchard management than larger trees particularly in the first 3 to 5 years after planting. The importance of doing small jobs such as training, tree support, spraying, weed control etc., when they need to be done cannot be over-emphasized in high density plantings.

For home garden plantings, M 9 is the only rootstock that will produce a tree small enough to be managed with backyard gardening equipment. Since most apple cultivars need cross pollination, it will be necessary to have several trees of different cultivars to insure adequate fruiting. The small size of trees on M 9 make them ideal for ornamental trellises or espaliers against buildings.

Malling 26

Less is known about M 26 because it was released only recently by the East Malling Research Station in England. It resulted from crossing M 9 with the very vigorous non-dwarfing M 16.

Experience in Ohio and elsewhere indicates that the important commercial cultivars grown on M 26 are larger than on M 9 and only slightly smaller than M 7. Trees on this rootstock grow very rapidly in their early life with growth decreasing as fruiting begins. Results thus far indicate that trees propagated on M 26 require staking during their entire life. Sucker growth so common with M 7 is largely eliminated with the M 26 stock.

The experimental trees in Ohio have not produced the high early yields others have reported. Its precocity appears to be similar to that of M 7 but not as good as M 9 or MM 106.

In Ohio and elsewhere M 26, seems to be intolerant of wet soil conditions. Severe loss (up to 40%) has occurred in some of our research plantings and also some commercial plantings on this rootstock. The cause of these losses is still undetermined but collar rot and fireblight are both possibilities. The organism responsible for collar rot has been isolated in one of our declining plantings.

According to a study in Minnesota M 26 is one of the hardiest of the Malling rootstocks being similar in hardiness to Robusta #5.

Although we still have much to learn about M 26, it presently appears that planting of this rootstock on soils that are imperfectly drained cannot be recommended.

Malling 7

For commercial orchards M 7 has proven to be very productive and has been planted extensively in this country. However, trees propaged on M 7 have frequently attained a size somewhat larger than expected as is evidenced in past plantings at the Ohio Agricultural Research and Development Center. On less fertile soils in other areas of the state a greater degree of size control has been shown.

Past work, conducted by Dr. Freeman Howlett, shows that trees on M 7 have borne their first flowers the fourth year following planting. This is two years before the same cultivars on seedling rootstocks. However, a greater difference was evident with Delicious and Northern Spy which normally begin bearing relatively late in life.

The anchorage of M 7 is only moderate and some trees in most plantings lean and need support. Unless the site is exposed to constant wind, the number of

trees requiring support is relatively small. However, if M 7 is planted a reserve of posts should be available to support the trees that lean.

One of the major disadvantages of M 7 is its tendency to produce suckers which must be controlled for sound orchard management. Reports from Michigan indicate that budding the trees 16 inches high and planting deeper will reduce suckering and improve anchorage.

The hardiness of M 7 is approximately the same as domestic apple seedling. M 7 is susceptible to collar rot and although reported to be slightly more tolerant than MM 106, for practical purposes both should be avoided on heavy wet soils where this disease is known to occur. M 7 is moderately susceptible to fireblight in the nursery, but there are no known reports of direct entry into the rootstock with a scion cultivar on top.

Trees propagated on M 7 develop an open spreading growth habit, and extra care in training must be exercised if a central leader tree is to be maintained. Yields from M 7 trees have been excellent, and it will continue to be recommended and widely planted in orchards desiring a tree 60 to 70% the size of a standard tree.

MALLING MERTON ROOTSTOCKS

The Malling Merton (MM) series of rootstocks originated from crosses of the Malling series and Northern Spy with the intent of developing resistance to wooly aphids. Although the rootstocks in this series are resistant to wooly aphids, the tree sizes produced are all larger than M 7.

Malling Merton 106

MM 106 is very nearly a standard size tree with vigorous cultivars in fertile Ohio soils. The main advantage of MM 106 is that it is well anchored and needs no support. It is also very precocious and rivals M 9 in causing cultivars to bear at an early age. Winter hardiness of MM 106 is similar to domestic apple seedlings. It does, however, cause most cultivars to grow late in the season which may make them more susceptible to early fall freezes.

Cultivars on this rootstock are predisposed to greater infections of fireblight than the same cultivars grown on other rootstocks or domestic seedling stocks. The reason for this is unclear but possibly it is related to more active shoot growth later in the growing season. This rootstock is also one of the most susceptible to collar rot and should not be planted on sites with heavy wet soil or soils with a history of collar rot.

Suckering is not a problem with MM 106, and it has been a very efficient rootstock for interstem trees where the soil conditions permit its use. Since the growth habit is vigorous and upright during the early years the use of limb spreaders is advisable particularly with spur type cultivars.

Malling Merton 111

MM 111 is another of this series that produce well anchored free standing trees. Trees on this rootstock are large and on fertile soils result in nearly standard size trees. Growth of trees on MM 111 is upright and vigorous and limb spreaders should be used with all cultivars to develop and position the scaffold limbs. Since the precocity induced by MM 111 is simlar to apple seedling, cultivars that are slow to begin bearing should not be planted on this stock.

MM 111 is well adapted to various soil types and has shown a greater degree of drought tolerance than many other rootstocks. Winter hardiness of MM 111 is slightly greater than domestic apple seedling, but is not as hardy as M 26 or Robusta #5. MM 111 is one of the most tolerant of the clonal rootstocks to fireblight in the nursery. Although susceptible to collar rot, it is more tolerant than MM 106 or M 7. Since MM 111 does not sucker and has an extensive root system, it has performed well as a rootstock for interstem trees.

OTHER APPLE ROOTSTOCKS

The following rootstocks are occasionally available from commercial nurseries, but since they are not widely planted or recommended, only a brief description will be presented.

Malling 1

- This rootstock produces a large tree with no decided advantage over other similar size producing rootstocks. M 1 is very susceptible to fireblight.

Malling 2

- This stock has been widely planted in Europe in the past but is now being replaced by MM 111 and MM 106 for this size tree. Trees on this stock are large, and precocious. It tends to lean on heavy soils.

Malling 4

- M 4 produces trees the same size as MM 106 and is poorly anchored thus requiring permanent support. It is very precocious and resistant to collar rot and has been planted because of this tolerance.

Malling 13

- This rootstock produces essentially standard sized trees and is rather shallow rooted. According to a report from New York State M 13 offers the best possibility of tree survival on wet sites where some water logging exists.

Malling Merton 104

- Trees on this stock are larger than on MM 106 and very susceptible to collar rot. MM 104 should not be planted on any soil that tends to be at all wet or very retentive of moisture.

Malling Merton 109

- It produces full size trees and is reported to have borne heavier crops than other standard size rootstocks.

Domestic Apple Seedling

- This rootstock produces large free standing trees that are slow in coming into production. The disease susceptibility, suckering potential and growth habit of each tree is different and unpredictable.

SUMMARY OF SOME IMPORTANT APPLE ROOTSTOCK CHARACTERISTICS

Rootstock	Size	Anchorage	Precocity	Soil Adaptability	Disease Susceptibility	General Comments
M 9	20-30%* Ht. - 8'	Poor - Must support	Excellent 2-4 yrs.	Avoid droughty	CR** - Resistant FB** - Susceptible nursery	Spreading habit Attractive to mice Suckers
M 26	45-50% Ht.10'-15'	Poor - Must support	Good 3-5 yrs.	Avoid heavy, wet	CR - Susceptible FB - Susceptible	Does not sucker Winter hardy
M 7	50 - 60% Ht.15'-18'	Moderate - Support when needed	Good 3-5 yrs.	Well adapted	CR - Susceptible FB - Moderately susceptible nursery	Suckers Spreading habit
MM 106	75-85% Ht.18'-22'	Good	Good 2-5 yrs.	Avoid heavy, wet	CR - Susceptible FB - Moderately susceptible nursery	Scions more susceptible to fire blight Does not sucker
MM 111	80-90% Ht.22'-25'	Good	Fair 5-7 yrs.	Well adapted, drought tolerant	CR - Moderately susceptible FB - Tolerant nursery	Vigorous upright Need limb spreaders Does not sucker
Apple Seedling	100% Ht.25'-27'	Good	Poor 5-9 yrs.	Well adapted	Varies from tree to tree	Too large to be efficiently managed. Suckering, disease susceptibility vary from tree to tree.

*Approximate size percentage of a standard tree on domestic apple seedling rootstock.
**CR - Collar Rot, FB - Fireblight

SIZE CONTROLLING INTERSTEMS

Since a free standing tree slightly larger than M 9 is desired, interstem trees using a 4-12 inch stem piece of M 9 grafted to a well anchored rootstock with the scion cultivar on top have been offered as a possibility. Of course other clones may be used as interstems but M 9 appears to have the greatest potential in keeping tree size minimal. Although this concept of tree size control has been around for many years, we have only limited experience with these trees and much more needs to be known before all the advantages and disadvantages can be properly weighed.

Various studies show that as the length of interstem increases ultimate tree size decreases. The interstem length most commonly considered is approximately 6 inches which results in a tree approximately 20 to 40 percent larger than the same cultivar on M 9. All observations indicate that regardless of the interstem length the interstem tree will be larger than the same cultivar grafted directly on M 9.

The rootstock to be used with an interstem tree should be well anchored and well adapted to various types of soil. Apple seedlings, MM 106, MM 111, Hibernal, and Alnarp No. 2 have all been used as understocks for dwarfing interstems. If the rootstock has some size controlling ability of its own, the resulting interstem tree will reflect this additional effect. The disease susceptibility of the various rootstocks should be considered. For example the collar rot susceptibility of MM 106 and the fireblight susceptibility of Alnarp No. 2 and Hibernal make them questionable choices if these diseases are a problem. Since the use of a dwarfing interstem causes a rootstock to sucker more than usual, the rootstock used should be relatively free of a suckering habit which can be a severe problem when apple seedlings are used.

PLANTING DISTANCES

It must be emphasized that environmental and cultural practices along with the fruiting habit of the scion cultivars are as important as the genetic nature of the rootstock in influencing ultimate tree size. European growers with detailed summer pruning and branch bending can control growth and greatly reduce tree size, thus enabling them to plant very close. In the United States traditionally much less time is devoted to training and pruning and this must be considered when a planting distance is selected.

Because it is impossible to adequately cover all the soil types and degrees of pruning and training that are practiced by numerous growers, the following conditions have been established as a basis for the planting distances suggested in the following table: 1) A description of an excellent soil would be a deep, well drained, clay loam or silt loam with high fertility similar to the Wooster silt loam at the Research Center. The fair soil class would include sandy soils or thin soil over shale, and a moderate soil would lie somewhere between these two extremes. 2) the trees will be trained as central leaders, 3) limb spreaders will be used when needed particularly with spur types, 4) nutrition will be balanced with growth and based on foliar analysis, 5) trees will be maintained as hedgerows 6) the rootstock will be the primary means of size control with little assistance from pruning. The distances suggested are based on experimental studies in Ohio and observations of commercial Ohio orchards.

SUGGESTED PLANTING DISTANCES BETWEEN TREES

Rootstock	Cultivar[1]	Soil Character		
		Excellent	Moderate	Fair
M 9	Delicious	10	9	Avoid
	Golden Delicious	8	7	Avoid
	Spur Delicious	5?	Avoid	Avoid
M 7	Delicious	17	15	14
	Golden Delicious	14	12	10
	Spur Delicious	12	11	10
MM 106	Delicious	20	18	16
	Golden Delicious	18	15	13
	Spur Delicious	16	14	12
MM 111	Delicious	20	18	16
	Golden Delicious	18	15	13
	Spur Delicious	16	14	12
Interstem M 9/ MM 111	Delicious	12	10	9
	Golden Delicious	10	8	6
	Spur Delicious	10?	9?	6?

[1]Distance for other cultivars should be determined by comparing tree size with the cultivars mentioned and adjustment made accordingly.

If any of the predescribed conditions are changed, the planting distances should be adjusted for this change. For example if M 9 is to be trained on a wire trellis as an oblique palmette, the distances would be adjusted to 8 feet in the row and 12 feet between rows in an excellent soil for Delicious. Since each cultivar grows differently it should be compared to the above cultivars and the distances adjusted accordingly. Spur growth habit as indicated above also exerts some size controlling influence and this should be considered. The planting of spur types on M 9 is generally not recommended however, results of this combination at Wooster have shown some promise if adequate growth can be achieved prior to fruiting. There is little information available as a basis for the planting distances of interstem trees and the above suggestions are based on very limited observations.

The distance between rows also depends on several factors that each grower must determine for himself. The size of equipment available and the method of handling harvest are two important considerations. If tree growth between rows is handled similarly to the growth between trees in the row, a distance of an additional 8 feet is generally needed for average sized equipment. For example if the in row distance is 12 feet the distance between rows would be 20 feet (12' + 8' = 20').

PEAR

The propagation of dwarf pear trees has been practiced for many years in Europe and this country. At present the usual procedure in the United States is to propagate the pear variety desired upon some type of quince, the preferable one being Angers Quince East Malling Type A. This vegetatively propagated strain was found superior for this purpose by the East Malling Research Station in England. Rooted cuttings are available at several nurseries.

Certain pear varieties apparently do not grow satisfactorily if budded or grafted directly upon quince. In the propagation of dwarf trees at the Ohio Agricultural Research and Development Center the Old Home pear variety is budded on Angers quince rooted cuttings and thereupon serves as an intermediate framework for the desired pear variety. Old Home has been found to be compatible with over 200 pear varieties and is constantly used in the propagation of all pear trees including those established on Bartlett pear seedlings. Old Home is very resistant to infection by the fire blight organism and has permitted the maintenance of these varieties, many of which are very susceptible to the diseases.

Dwarf pear trees may be planted 10 to 15 feet apart in the row and the rows 15 to 18 feet apart. In view of the fact that the number of fruits on dwarf trees are naturally limited due to tree size, as many trees to an acre should be planted as is consistent with efficiency in carrying out the necessary orchard operations.

PEACH

In relation to the apple and pear, size-controlling rootstocks for the peach and other stone fruits have received comparatively little attention. Some interest among home gardeners has been shown in the past for dwarf peaches and plums. In recent years, commercial growers are also beginning to show interest in rootstocks for these fruits.

In the past, the peach has been restricted in size to some extent by certain training and pruning practices. However, today with greater interest in high density plantings, an increased reduction of tree size is required. Moreover, in pick-your-own operations a smaller tree is needed.

Recently, two peach rootstocks from Canada - Siberian C and Harrow Blood have shown some reduction in tree size of peach cultivars grafted on them. In addition, these rootstocks are noted for their hardiness to low temperatures. Of the two rootstocks, Siberian C is the favorite.

The Western Sand Cherry (Prunus basseyi) and the Nanking Cherry (Prunus tomentosa) have been found to produce somewhat satisfactory dwarfing of the peach. Some incompatibilities have resulted with these stocks and virus-free material should be used. Moreover, it is very desirable to use asexually propagated stocks to eliminate the variability encountered here.

In certain European countries as England and to some extent in Canada, the St. Julien plum has had a slight dwarfing effect on peach cultivars.

PLUM

Dwarf plum trees are offered for sale by a few nurseries, but usually the rootstock is not specified. Most of the size-controlling rootstocks listed above for the peach are also applicable for plums. The most commonly used have been the Western Sand Cherry (P. besseyi) and St. Julien plum. Again virus-free seedlings and clonal material are preffered.

CHERRY

Prunus besseyi has been used to dwarf the cherry, but the bud take is often poor. Other rootstocks used to some extent and which offer some promise are Prunus mahaleb (Mahaleb Cherry) and Prunus fruticosa (Ground Cherry).

SUMMARY AND GENERAL CONCLUSIONS

For the production of fruit commercially each of the dwarf and semidwarf rootstocks mentioned have a place. The fruit grower must determine this over all goal in his future planting and then use as a tool the size controlling rootstock that most closely fits that goal.

For the production of dwarf apple trees for the home garden M 9 is the most desirable rootstock. However, trees on this stock must be supported and care should be exercised to provide optimum growing conditions the first few years of the tree's life.

Fruit growing is presently on a miniaturizing trend and dwarfing rootstocks for all species are being actively sought and their influences studied. New breeding programs specifically to develop rootstocks adaptable to conditions in this country and resistant to our problem diseases are currently in progress. Research is also underway to develop the most efficient methods to produce fruit on small trees planted close together. New rootstock introductions coupled with research results will produce many dramatic changes in the rootstocks used in the next decade.

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